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Unmanned Air Vehicles for the Army - Future Concepts

(Ankara 26 - 28 April 1999)

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The lecture comprises the following contents:

1. Starting Position
1.1 UAV Systems of the German Army
1.2 BREVEL: Target Reconnaissance and Target Localization
1.3 MÜCKE: Jamming of UHF/VHF Ground Radio Links
1.4 TAIFUN: Combat against High-value Ground Targets

2. Technology Basis of Future Drone Systems
2.1 Core Components and Functions
2.2 System Core as Starting Basis for System Variants and Integral Solutions
2.3 Main Emphases of Future Developments

3. Future Concepts
3.1 Examples for System Variants and New Systems

4. Summary

0. Preface

The micro drones are not considered in this report because the required technologies and special branches have to be applicated with partly completely new attemps and approaches. As examples for this statement I will mention only the aerodynamics, the microelectronics and micromechanics as well as bio-chemical sensors and neuronal intelligent structures.

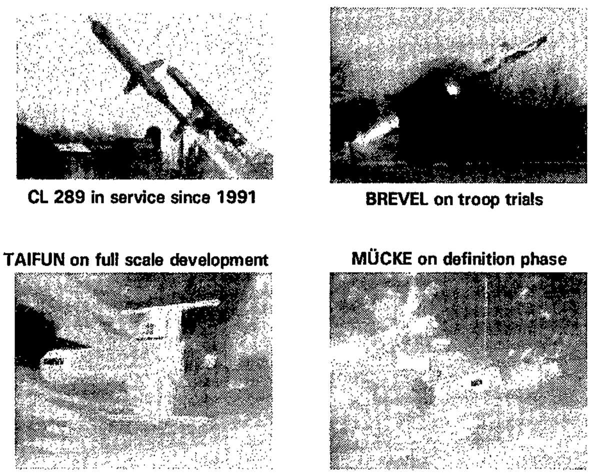
The way shown here to future UAV systems goes ahead from of the existing and in near future developed technologies for tactical UAV systems and demontrates about application variants the direction towards far-reaching UAV systems with NATO compatibility.

1. Starting Position

1.1 UAV Systems of the German Army

Since the introduction of the reconnaissance drone CL 289 in 1970 the German Army collected more than 25 years experience with reconnaissance drones.

The intensive and knowledge based concern with UAV technologies has led to this, that drones will also be set into operation for combat and jamming support by the German army.
The drone system CL 289 for real time tactical reconnaissance is up to 75 km penetration depth in operational



CL 289 in service since 1991 — BREVEL on troop trials — TAIFUN on full scale development — MÜCKE on definition phase

Fig. 1-1: UAV Systems of the German Army

use. In the following report we will learn about the peacekeeping missions of the CL 289 in Bosnia.

The drone system BREVEL is now under test in troop trials and is put into service in 2001.

The combat drone of the German Army TAIFUN will be put into service in 2005, the development started in mid 1997. With this weapon system the army attains for the first time the ability for operative combat in the depth.

The jamming drone MÜCKE is tested during the defination phase with prototypes in flight trials on the basis of the BREVEL system. The introduction into service is planned for the year 2004.

The drohne systems BREVEL, TAIFUN and MÜCKE will be realized under the responsibility of STN ATLAS Elektronik GmbH, Bremen.

I like to introduce these three systems to you briefly.

1.2 BREVEL: Target Reconnaissance and Target Localization

The drohne system BREVEL will be used by the artillery for acurate target localization, post strike reconnaissance and for the extraction of information of the operational situation.

The information are obtained by means of a stabilized, ground controlled infrared onboard camera and are sent in real time via a jam resistant data link to the ground

Paper presented at the RTO SCI Symposium on "Warfare Automation: Procedures and Techniques for Unmanned Vehicles", held in Ankara, Turkey, 26-28 April 1999 and published in RTO MP-44.

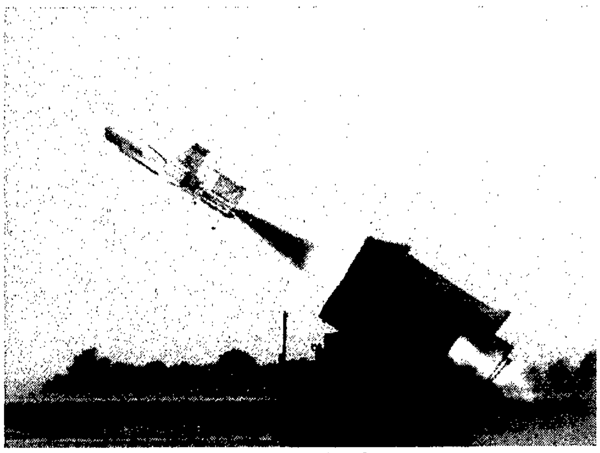


Fig.1-2: Booster Launch of BREVEL

control station. The flight profiles for each mission are preplanned in the ground control station and can be changed during flight at any time.

A BREVEL system includes:

- 10 air vehicles
- 2 launch vehicles
- 2 ground control stations
- 2 antenna vehicles
- 2 maintenance vehicles
- 2 recovery vehicles

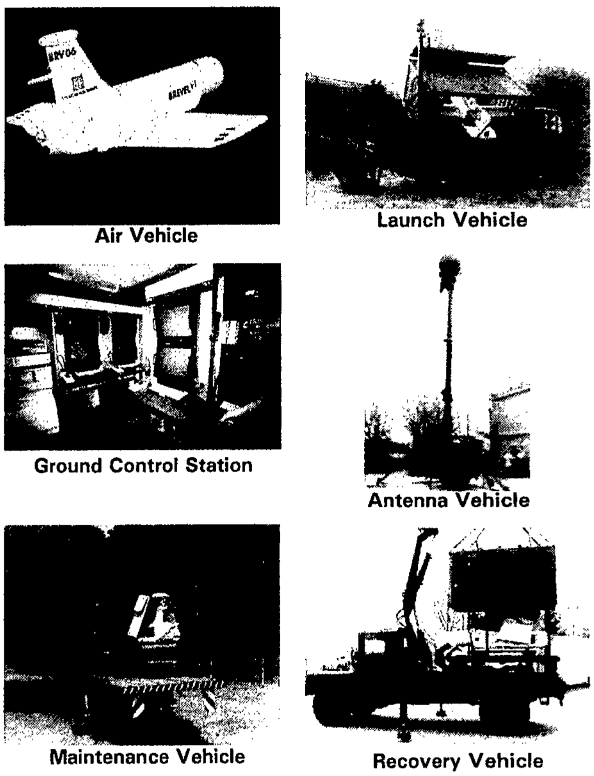


Fig.1-3: System Elements of BREVEL

The tailless configuration of the BREVEL drone has particularly proved itself at extreme wind conditions. The air frame is produced in a material compound structure with radar energy absorbing features and also in an infrared, acoustic and visual signature reduction manner, which was developed by STN ATLAS. After having received the mission order the drones have to be launched rapidly and without restrictions for the launch direction. Therefore the launch is carried out with a booster from the launch vehicle.

The ground control station has 3 work stations for mission planning, mission guidance and control and sensor image evaluation.
The data link antenna at the ground can be seperated from the ground control station up to 1000 m.
After the landing the drone is transported by the recovery vehicle to the maintenance vehicle. Here the drone is prepared for the next flight and refueled.

Fig.1-4: BREVEL on Winter Trials in Finland

On invitation of the Finnish Forces a complete BREVEL system was shipped to the Kemijärvi-Airfield in Finland in April 1998, north of the polar circle. BREVEL demonstrated successful flights even under extreme wintry conditions at temperatures of - 28 ° C.
Our figure shows the drone after its successful flight and parachute landing just before picking up by the recovery vehicle.

1.3 MÜCKE: Jamming of UHF/VHF Ground Radio Links

The jamming drone MÜCKE is to be developed on the basis of the reconnaissance drone BREVEL.
For example the MÜCKE ground control station is taken from BREVEL as well as the tailless air vehicle configuration.

Instead of the IR payload a broadband jammer of high power in the UHF/VHF band will be installed as payload into the MÜCKE drone. The BREVEL video data link will be replaced by a HF data link. The basic functions of the drone (air frame, engine, flight control, navigation) are fulfilled by unchanged BREVEL components .
The MÜCKE system gets tied to the "ELoGM-Einsatztrupp". In the context of the ongoing definition phase

prototypes with jammer payloads will be ready for the maiden flight in June of this year

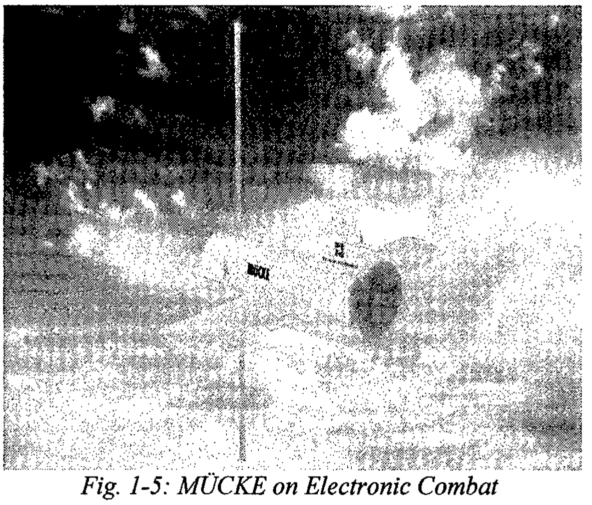


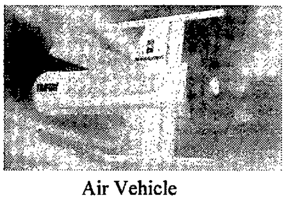
Fig. 1-5: MÜCKE on Electronic Combat

1.4 TAIFUN: Combat against High-value Ground Targets

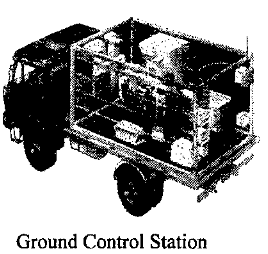
Within the command responsability of a corps the combat drone TAIFUN attacks ground targets like

- armoured vehicles
- command posts
- logistical facilities
- artillery in firing position
- helicopters on ground

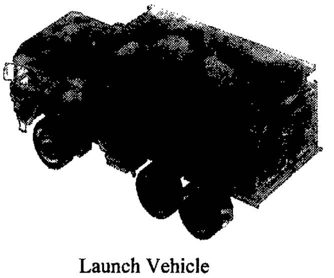
and other high-value targets and will also be committed to block areas.



Air Vehicle



Ground Control Station



Launch Vehicle

Fig. 1-6: Combat Drone System TAIFUN

All three drone systems come into being under the common philosophy of "One German Army Drone Family", which was jointly developed with the military user. This philosophy enables the sectional application of technologies, procedures and components for further drone systems as variants for future tasks. This family concept pays off in the service phase by common sequences of operations and common logistics.

2. Technology Basis of Future Drone Systems

2.1 Core Components and Functions

How system variants can be derived from the drone family concept was already shown at the example of the jamming drone MÜCKE.

The existing and arising components which are in accordance with the drone family concept of the German army form a system core, which will be common for all future drone systems. This system core is also available for arms overlapping activities as e.g. for the navy drone or for "Future Lessmanned Aircraft Operations" (FLAO).

This system core comprises the functions:

- mission planning
- mission control and guidance
- flight guidance/control and navigation
- sensor data processing and communication

Besides the advantages for new developments the use of the system core is aimed particularly on the increase of the system reliability, the more economical spare part stockpilling as well as simplification of handling processes and higher interoperability in the ground control station.

The extent and the performance of this system core increases with the development progress.

When developing new drone systems this core will be improved by task specific components like e. g. :

- payload specific guidance, control and evaluation software
- Interfaces

or also by available core components.
On ground the improvement of the system core shall lead to a ground control station usable for many drone systems. The following figures show some examples for the develpoment status of the system core and jointly applicable compoments and represent the starting position for system variants and integral solutions.

2.2 System Core as Starting Position for System Variants and Integral Solutions

A starting position for system variants and integrated solutions represent the following system cores:

Ground Control Station
The following functions must primarily being covered by the ground control station

- Communication

- Mission planning and system control
- Image representation and evaluation

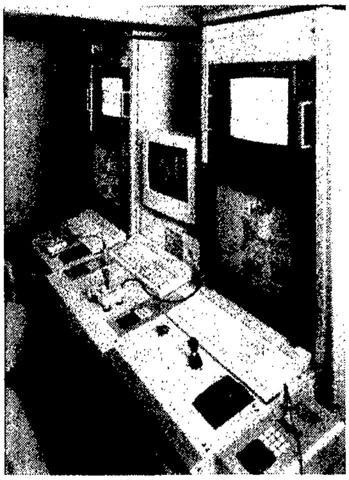


Fig.2-1: Ground Control Station

The goal of the ongoing development is the standardization by using commercial PCs, network technologies and ergonomically as functionally mostly equal opera-tor consoles.

The communications are carried out via terrestrial connections with radiotelephone systems and data links in which SatCom also is used.

Mission planning and system monitoring starts with the planning of the mission on the digital map, in which is prepresented the operational state received via ADLER data link. Direct changes of the running mission during drone flights are possible at any time.
The image prepresentation and evaluation comprises an image/map comparison for navigational purposes as well as a corresponding processing of sensor data and images for target reconnaissance and target localization.

Flight control and guidance system

In context of the TAIFUN development a performance standard is reached for the flight control and guidance system, by which the common usability of additional interfaces is extended as e.g. for friend-or-foe identification and a larger computer capacity is assigned for free programmable mission intelligence.

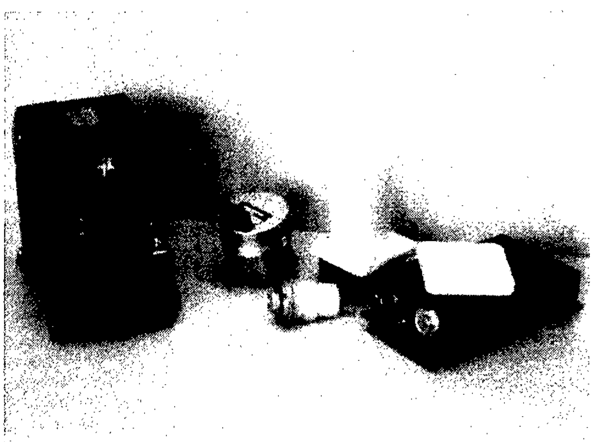


Fig.2-2: Flight Control and Guidance System

Data Links

Still considerable need for standardization exists for the data link connections between ground control station and the flying drone.

The different requirements regarding range, jam resistance, data rates and costs haven't been able to result to a common component till now.

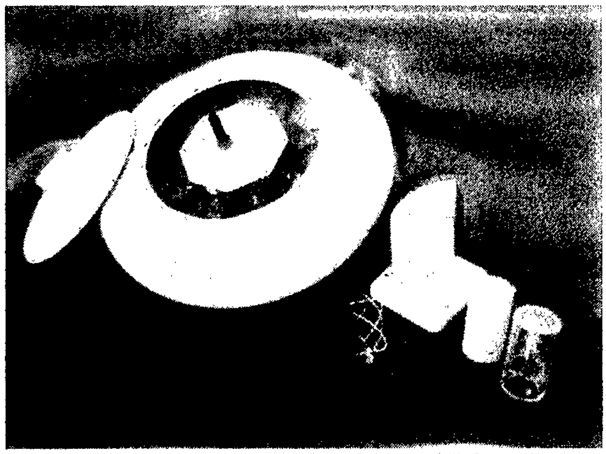


Fig.2-3: Antennas for Video, GPS and Telemetry

Fig.2-4: SatCom Device for Land Vehicles

The current need for far-reaching data links of high data rates for video transmission in real time can be met however in future by the use of SAT COM devices.The starting position for the realization of this solution is available at STN ATLAS taking into account the experience and application of such products which collected STN ATLAS in other divisions of the company.

Engines

A gap of equipment still exists at the engines for drones. Longer flight times and higher speeds require a light kerosene motor in the 32 KW class of low consumption.

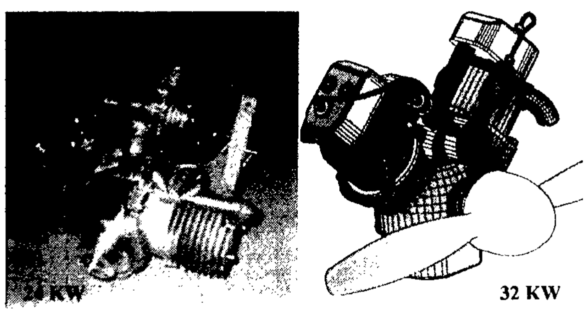


Fig.2-5: Two-Stroke Engines

Stealth Measures

To increase the survivability of drones in the operational area, measures to reduce the signatures in all spectral ranges are absolutely required . This also includes the camouflage against radar acquisition. At the BREVEL radar signature reduction one has to distinguish between radar absorbing material, radar transparent material and radar reflecting material.

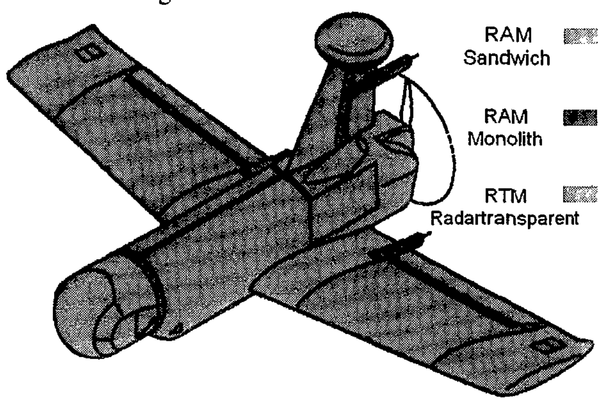


Fig.2-6: Radar Camouflage Design of BREVEL

STN ATLAS disposes of a radar signature measuring chamber especially developed and equipped to measure very precisely small radar cross sections about a broad frequency domaine for real drones and drone components. The measuring results are analysed two-dimensionally to reveal the causing scatter centers.

2.3 Main Emphases of Future Developments

After we have got an overview over the status of the drone family of the German Army now, I like to answer two questions:

a) Which possibilities opens this technology basis?
b) What are the focal points of the development?

To a)

The development of new systems concentrates in future on the integration of available components taking into account new technologies and the supplementation around task specific parts. The use of the system cores and available components facilitate shorter development schedules and prototyping.

To b)

In the area of air vehicle technology longer flight endurance and larger payload capacities must be reached. With this the possibility of applying payload combinations is created. Payload modules with standardized interface shall facilitate to equip the same drone for different tasks by payload exchange on ground.
A higher degree of automatization of the sensor systems must be reached by improved pattern recognition, target classification and sensor data fusion so that the operating team can more concentrate on the original military tasks. Future drone systems must also be tied up to IFF systems.

For larger penetration depths at simultaneous online transmission of sensor data the development progress of the satellite communication must be used. The progress on the civilian sector assures the required data rates. The neccesarily small built in volumes of the SatCom antennas will be reached by the improvement of phased array antennas.

The increasing meaning of operations of the allied forces together with partners of the NATO states requieres increasing demands on communications. The realization of this interoperability cannot be carried out in the context of the running drone programs.

The ground stations must however have the corresponding interfaces to be able to exchange data with the different communication devices so how this happens at the German drone family via ADLER.

With the growing number of drone operations the question concerning their imbedding in the air surveillance / air traffic control has arised onto a decisive meaning. Therefore the drones have to be equipped correspondingly, e.g. with anti collision lights, access redundancy and transponders.
The procedures for imbedding into the air surveillance, e.g. via communication with the drone ground control station, but also for airworthyness and air certification of the drones have to be defined.

3. Future Concepts

For the future concepts of new drone systems the following technological areas are decisive:

- Air Vehicle Technologies
  - longer flight endurance
  - capacity for payload combinations
  - exchangeable payload modules
- Sensor Technologies
  - pattern recognition and target classification
  - sensor data fusion
  - IFF system
- Communication
  - LOS independant, long range data link
  - interoperable communication devices
- Flight control and flight surveillance
  - integration into the air surveillance / air traffic control

3.1 Examples for System Variants and New Systems

In the last section I like to show you some examples, how future tasks can be realized by system variants on the base of the drone family of the German Army or on the base of the system core. The appertaining task areas already are treated mostly in ongoing studies.

A large portion of the tasks can be fulfilled by system variants on the base of the drone family.

Thereto belong:
- RECCE / STRIKE
- Helicopter suppression

- Weather data acquisition
- Reconnaissance of mine barrages
- Electronic reconnaissance
- ABC reconnaissance

for which payloads corresponding to the tasks have to be integrated into the systems BREVEL or TAIFUN

RECCE / STRIKE

The next picture shows the screen splitting of the ground control station simulator of the demonstration program RECCE/STRIKE concept.

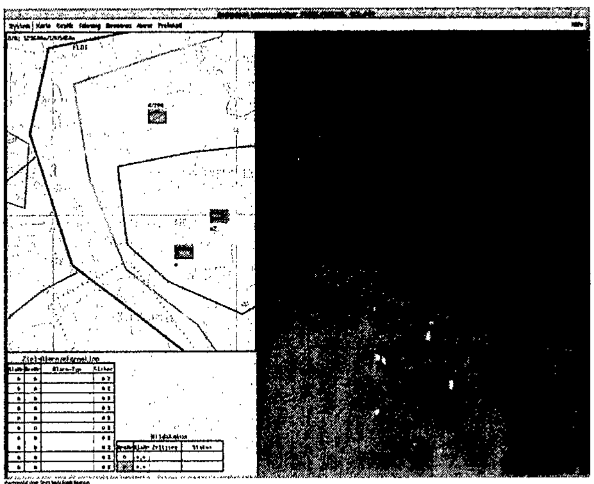


Fig.2-8: Sreen of the Image Interpreter

The prepresentation of flight path of the drone and the acquired ground targets on a digital map are completed by the prepresentation of radar and TV or IR images in correct positions.
The guidance of the drone can be both programmed freely before the start and entered during the flight directly.
Extensive simulations of drone flights with military operators permit as well the operational and system engineering like assessment of the system concept as its purposeful further development.

Weather Drone

The following picture shows an example for a system variant on the base of BREVEL.

To increase the target hit accuracy and to save ammunition for the far-reaching artillery weather data have to be collected from different altitude layers of the target area. For this purpose probes are dropped from the drone over the target area. These probes transmit the weather data to the drone which in turn passes these to the ground control station.

The realization is carried out with modified BREVEL prototypes because it is an integration task. After these here shown drive and wind tunnel trials in the meantime flights with ejections of probes have been carried out successful.

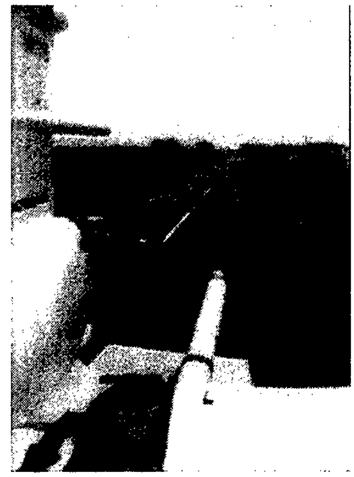


Fig.2-9: Drive Trials for Drop Probe Ejection

Inboard Profile

An additional payload in the range of the center of gravity allows the use of modular sensor components and warheads as well as aditional kerosine tanks to enlarge the fuel stock for prolongation of the flight endurance.

The use of a power tuned engine yields in connection with the integration of a constant speed propeller to an increase of the flight speed.

The external shape of the lightly sweeped tailless configuration of the air frame allows that the compo-nents up to now arranged cylindrically in the middle section of the air frame can be distributed over the two-dimensional structure from now on. Signature specific aspects are influenced positively by this configuration furthermore.

System Elements of LUNA

Not only in the tendency of larger, heavier, longer ranges are future drone developments conceivable but also in the opposite direction of light-weight close reconnaissance systems (LUNA). Trials have been started in this direction also by our company. The main features are:

The air vehicle with
- plug-type wings for low transport dimensions
- GPS for autonomical navigation

Ground control station with
- cross country, self-supporting vehicle as ground control station including
  - two video work stations
  - TM/TC and video data link
  - antenna stack

- catapult lauching gear as test model
  - based on pressure gas for short set-up time

The company EMT develops such a system very successful. The system is presented by one of the following reports.

Far-reaching drone

The tasks of a far-reaching, deep penetrating drone with long dwell time over the target area require drones on the base of the system core.
It becomes in one the platform for further missions with long flight endurance.

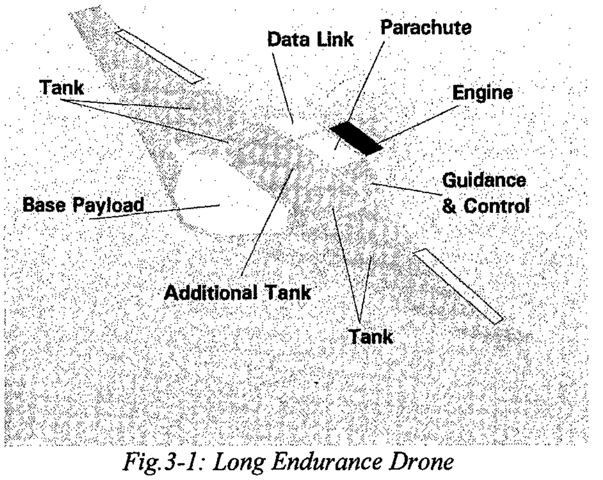


Fig.3-1: Long Endurance Drone

The figure shows a conceptual design for a far-reaching drone with long flight endurance. As design criteria were predefined:

- The use of the system core supplemented by a SatCom device
- Integration of an existing IR payload
- Possibility of an additional payload
- Flight speed up to 400 Km/h for short cruise times
- Mission endurance up to 12 h

Proven techniques for launch and recovery can be applicated on one hand like:

- Booster launch and
- Parachute and air bag recovery

and on the other hand new launching procedures on the base of catapult and conventional methods.

The time schedule "Technical Progress of Drone Developments" shows the termination of the development of the drone systems BREVEL, MÜCKE and TAIFUN representing the starting position of the future drone family of the German Army.

Based on that the system core has reached its highest extention stage in 2002. From this time on a new drone system, e.g. the far-reaching drone can be ready for a maiden flight within 2 years as prototype.

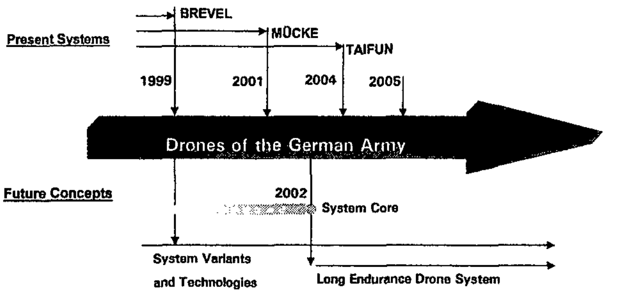


Fig.3-2: Technical Progress of Drone Developments

4. Summary

With putting into service of BREVEL, TAIFUN and MÜCKE the German Army becomes a leading force in the application of modern drone systems.

The drone family can get extended by system variants to cover more recently tasks.

A common usable system core is created by the drone family.

New drone concepts are build up on this system core.

Development activities can be concentrated on task specific components.

Development periods and costs are reduced by integral solutions and prototyping.